The Roster-in-a-Box Course Management System

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Abstract. Roster-in-a-Box is an open source course management system written in PHP, with a MySQL back end. It is designed to handle only the homework part of course management, leaving the instructor to design other parts of the course web page. It includes a complete semester of auto-graded assignment modules for introductory and intermediate microeconomics, and for introductory statistics, which I have quality-tested by using multiple times in my courses. I have evaluated the effectiveness of the system by comparing student test scores in my introductory statistics course before and after I began using the system (the material in the other courses changed to much before and after for exam performance to be comparable); there is weak evidence of improvement, and no evidence of worse student performance. I briefly discuss ways in which the software might be improved.

1 Introduction

Roster-in-a-Box is a course management system designed to facilitate the use of autograded homework assignments, while also allowing for text-based questions to be submitted online and graded online by the instructor. I developed and currently use the system for my introductory statistics and undergraduate microeconomics courses at Long Island University, and I have had it in production since 2005. While any instructor who tries hard enough could break the program, it is stable and very much ready for use.

I wrote the program because I wanted something simpler than Moodle (and also because my school was not supporting Moodle at the time that I started the project). I have no complaints about Moodle, but it was not right for me, because I did not want the course management system to take over my course web site. Roster-in-a-Box handles the homework and grading functions with a couple of web pages that can be inserted into any course web site. It requires the web server to run PHP and MySQL, but otherwise can be used quite flexibly.

The program consists of two web pages, namely a homework page and an administration module, as well as several utilities. Each page is its own PHP program. The homework page can be linked to from the main course web page, and is responsible for displaying, correcting, and recording all homework assignments. The administrative module, though password protected, should not

be made viewable to the rest of the world; the instructor can use this module to set up and modify the list of homework assigments, as well as to grade the manually graded assignments and track student performance. Additionally, small utilities display web pages through which students can request an account and view their grades.

The package comes with a set of modules for three different courses: Introductory microeconomics, intermediate microeconomics, and introductory statistics. I have used all of these modules in my teaching, so they are tested in that way. Each set consists of around thirty to fifty autograded questions based on material from the respective course; the instructor merely needs to use the administrative page to create an assignment, insert a module or modules into that assignment, and set the number of points for each question. The software takes care of the rest, although manually graded text questions can also be given. When a student enters an incorrect answer, the homework module explains how to solve the problem correctly. The student has as many chance as she wishes to try the assignment again with a different set of problems. Instructors can set a minimum score requirement below which the system will not accept an assignment. It is also possible to provide a late penalty for every day beyond the due date that the assignment is submitted, as well as a final cutoff date beyond which the system will not accept assignments.

The statistic modules cover summary statistics, probability, random variables, the Central Limit Theorem, confidence intervals, one- and two-sample hypothesis tests, and univariate regression. Nearly all of the sample problems are based on real-world data, and contain a sufficient number of exercises that it is very unlikely for a student to see the same problem twice. The introductory microeconomics modules cover topics such as supply and demand, consumer choice and demand, market demand, production, monopoly power, perfect competition, oligopoly, public goods, and externalities at the US introductory level. The intermediate microeconomics modules cover the same material at the US intermediate level, and are meant to accompany my open-source textbook, Intermediate Microeconomics, available from my web site at http://myweb.liu.edu/~tbarr. To some degree, the exercises reflect my idiosyncratic way of presenting the material for these courses, but I am confident that every instructor will find useful questions from the modules, and I welcome contributions from others.

There are also two administrative modules that I found a need for: One e-mails students when they have overdue assignments, leaving them without the excuse to complain that they did not know an assignment was due. It is also possible to e-mail announcements to the class using the main administrative page. The other module e-mails a backup of the roster to the administrator and can be

set to run on a daily or weekly basis; aside from protecting against catastrophic system failure, I find this useful when I need to respond to students who claim that the system "lost" their assignment.

2 Teaching Experience

Although I have used Roster-in-a-Box in three courses, I can only conduct a plausible before-and-after comparison in my introductory statistics course, because the material in the other two courses (introductory and intermediate microeconomics) changed as I implemented the system – chiefly because the time saved in class by not going over homework assignments freed me up to cover more material. Therefore I have examined the quantitative determinants of student performance in the statistics class, and their changes over time, to gauge effectiveness of the course management software.

Since the Summer of 2004, I have used the same computer program to generate my midterms and final exams. The program allows each student to get an exam with identically-worded questions but different answers, thereby making it far more difficult for students to cheat by copying answers from their neighbors. I change the wordings of the questions every year, but not the statistical calculations involved; this makes exam scores comparable year after year. In Summer 2004, the midterm covered measures of central tendency and dispersion, probability theory, and discrete random variables, while the final exam covered the Normal distribution, the Central Limit Theorem, confidence intervals, and one- and two-sample hypothesis tests.

The only major change came in 2005, when I switched to an online homework assignment system. Because I no longer had to go over homework assignments in class, my lecture time was freed up to cover more material. I therefore added one more topic (the Normal distribution) to the midterm, and added univariate linear regression to the final exam in its place. Therefore, the midterm became a bit harder (since it covered one more topic), while it is difficult to say whether the final exam became harder or easier (my inclination is to think that it became harder because regression is more difficult than the Normal distribution, but this is certainly a matter of perspective).

Other factors may have made exam performance incomparable between semesters. It is possible that my ability to explain material has improved, for example. I have also replaced contrived examples during my lectures with examples from actual data sources, which may keep students more interested. I do more in-class problem solving than I used to. And, I devote a little bit more attention to following up with under-performing students than I used to. Nevertheless, aside from the increase in material, the course content and the level

of difficulty has pretty much remained constant. It is with all of these caveats that I am comparing midterm and final exam scores between semesters over the last three and a half years. The homework scores are certainly not comparable before and after I introduced the online homework system, if nothing else because I used a different marking system. Nevertheless, within each of the two homework regimes, the assignments are quite similar.

Figures 1 and 2 show the mean, 25th, and 75th percentiles of exam performance between Summer 2004 and mid-Fall 2007 (Spring and Fall 2006 are missing because I was on leave). The online grading system was introduced in semester 4 (Summer 2005). The means suggest a slight upward trend, though with as much random variation between semesters as over time. The 75th percentile shows relatively little movement, while the 25th percentile is quite erratic; I can only hope that the apparent upward movement of that percentile over the last two to three semesters will continue.

Table 1 shows t-tests of whether the exam performance was better before or after the online grading system was introduced. The point estimates suggest a mean improvement of about four percentage points in both the midterm and the final exam, however neither result is statistically significant as a two-tailed test (both are borderline significant when considered as a one-tailed test). It is worth bearing in mind that the exams in the "after" case cover slightly more material.

Table 2 shows a regression of midterm performance on homework performance before and after online grading was implemented. The explanatory power of the homework exercises drops slightly after the implementation of online grading. I ascribe this mainly to the fact that the first homework assignment became easier (which allows the students a chance to adjust to the online grading system), and therefore a poorer predictor of midterm performance; the less significant coefficient on this assignment bears out that hypothesis. However, it is also possible that before I implemented the online system, I gave harsh marks to students whose homework pages suggested a poor understanding, holding constant the number of questions the student got correct, which would have made manual grading a more effective way to predict performance based on subjective indications. Table 3 repeats the same exercise for final exam performance. Here, the level of explanatory power is not too different between the online and manual grading regimes.

Table 4 performs regressions of final exam performance on both the relevant homework assignments, as well as on the first four homework assignments and midterm performance. The latter items should not contain any relevant material, but may predict overall student performance. In fact, these indicators taken together can predict about two thirds in the variation of final exam performance both before and after the online grading system was implemented. Table 5 shows

that the midterm score is a less successful predictor of the final exam score in more recent semesters; I hope that this is because I have been increasingly vigilant about intervening in the cases of students who perform poorly on the midterm.

Finally, Table 6 compares performance across different types of semesters. As my intuition would tell me, students in the Summer semester perform significantly higher than academic-year students (the point estimate is ten points higher, and the result is significant at the one percent level), but there is no significant difference between Spring and Fall semesters.

Overall, these numbers suggest that the online grading system had been modestly successful at improving student performance. Exam scores appear to have improved slightly and certainly did not worsen, and moreover, those exams cover more material than before the online system was implemented. The bottom quartile of student performance has not improved as much as I would like, and I should work on developing better mechanisms to assist the performance of this particular group of students.

3 Future Directions

Although I have a professional background in programming and systems administration, I wrote Roster-in-a-Box as a teacher trying to get a particular job done for myself, rather than as a developer generating a product for a particular audience. Nevertheless, I put a certain amount of effort into ensuring that the code is modular, generic, and reusable, and I hope that others may find that Roster-in-a-Box fits their needs.

At this point, the software does what I need it to do, so any further development would be to improve its usefulness to others. I have two ideas in mind. First, although the software does not take over an entire course web site, some instructors would prefer a product that does – that is, they should merely need to enter in topics on a syllabus template, links to course readings, etc., and the course web site is ready to go without them ever having to touch any HTML. I may try to add a module that allows users to do this.

The project that I would find most personally useful is to improve and expand the existing homework modules. I would like to add more questions for all of the courses; I would also like to add modules for other standard economics courses, such as macroeconomics, finance, industrial organization, health economics, etc. Finally, I would like to add features to the modules: First, by using AJAX routines so that students can draw graphs online; and second, allowing students to submit arbitrary files (such as spreadsheets, word processing documents, etc.) to be graded and returned.

Because modules can be written one-by-one, I hope that I can interest others who use the software to write a module or two on their own, and then send it back to me to include in the software. First, however, this requires getting others to actually use the software. I would urge readers and participants to ask themselves: What is the main reason you would not wish to use Roster-in-a-Box? What improvements in the software, if any, would get you to want to use it? I welcome any frank and honest feedback and suggestions.

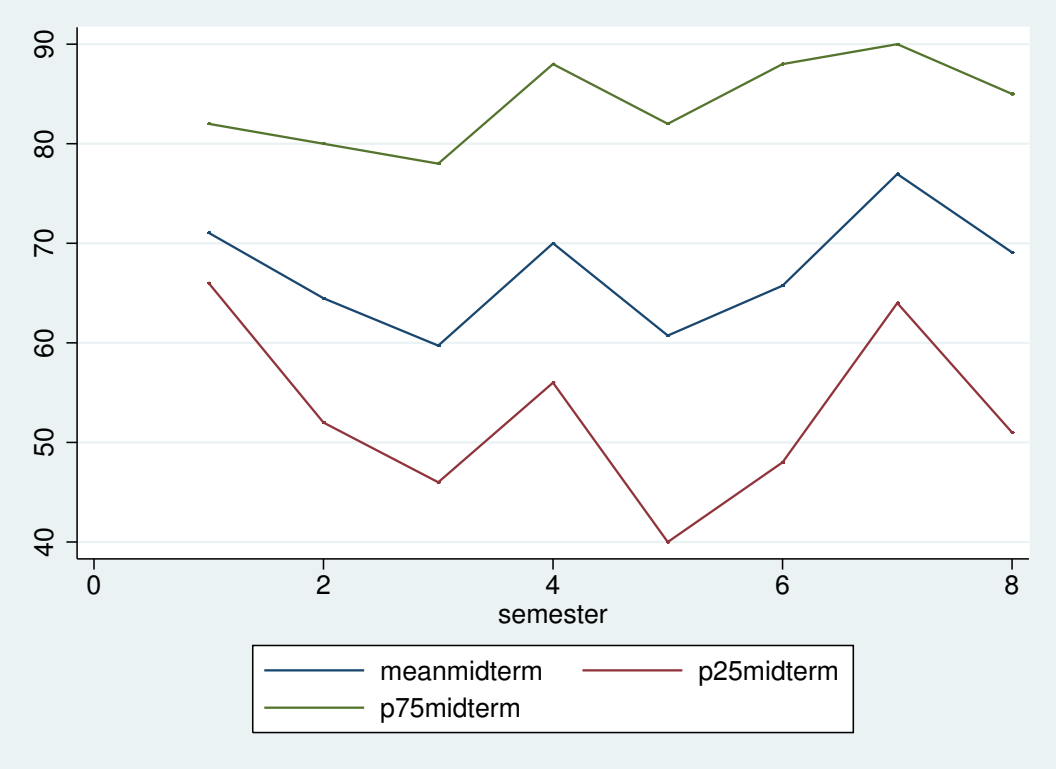

Fig. 1. Midterm Exam Performance by Semester

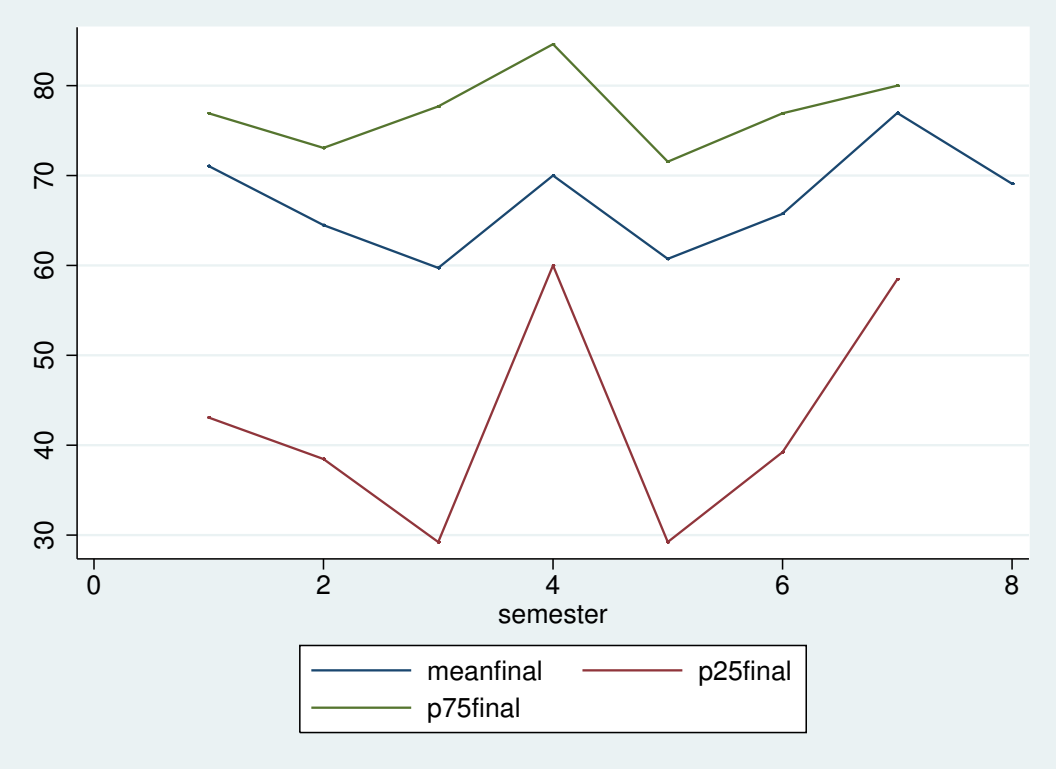

Fig. 2. Final Exam Performance by Semester

Exam	**No. Obs**	**Mean**	**Std. Dev.**	**95% Confidence Interval**
Midterm, Before Online Grading	89	$\bar{x}_1$ =63.67	21.03	(59.24,68.10)
Midterm, After Online Grading	204	$\bar{x}_2$ =67.02	22.64	(63.89.70.14)
Final, Before Online Grading	87	$\bar{x}_3$ =54.05	23.47	(49.05,59.05)
Final, After Online Grading	140	$\bar{x}_4$ =58.22	24.65	(54.10,62.34)

t test, equal variances assumed	**t Statistic**	**p-value**
$\mu_1 = \mu_2$ vs.$\mu_1 \neq \mu_2$	-1.1881	0.2358
$\mu_1 = \mu_2$ vs.$\mu_1 < \mu_2$	-1.1881	0.1179
$\mu_3 = \mu_4$ vs.$\mu_3 \neq \mu_4$	-1.2616	0.2084
$\mu_3 = \mu_4$ vs.$\mu_3 < \mu_4$	-1.2616	0.1042

Table 1. Means of midterms and finals, before vs after online grading

Independent Variable	**(1) Before Online Grading**		**(2) After Online Grading**	
Homework #1 Score (Old)	6.9791***	(1.8372)		
Homework #2 Score (Old)	7.9246***	(1.8897)		
Homework #3 Score (Old)	5.7744***	(1.6806)		
Homework #4 Score (Old)	5.8010***	(1.8763)		
Homework #1 Score (New)			0.1611**	(0.0768)
Homework #2 Score (New)			0.2107***	(0.0764)
Homework #3 Score (New)			0.2291***	(0.0678)
Homework #4 Score (New)			0.1898***	(0.0733)
No. Assignments Submitted	-20.7491***	(5.5652)	-11.2337**	(4.7705)
Summer '04	10.1041**	(5.0461)		
Fall '04	3.0874	(4.1672)		
Summer '05			1.5457	(6.6153)
Fall '05			-7.7052**	(3.7639)
Spring '07			-2.4503	(3.6773)
Summer '07			2.6072	(4.7630)
R^2	0.4095		0.2923	
Obs	89		204	

Standard errors in parentheses. Asymptotic two-tailed significance levels: * 10 percent; ** 5 percent; *** 1 percent

Table 2. Regression of midterm exam performance on homework, (1) before online grading, (2) after online grading

Dependent Variable	**(1) Before Online Grading**		**(2) After Online Grading**	
Homework #5 Score (Old)	7.2570***	(1.7980)		
Homework #6 Score (Old)	8.7313***	(1.6275)		
Homework #7 Score (Old)	7.9676***	(1.6827)		
Homework #8 Score (Old)	3.9323**	(1.7949)		
Homework #5 Score (New)			0.2057*	(0.1132)
Homework #6 Score (New)			0.3284***	(0.1190)
Homework #7 Score (New)			0.1288	(0.0861)
Homework #8 Score (New)			0.1192*	(0.0682)
No. Homeworks Submitted	-20.0672***	(4.9405)	-7.4453	(4.9486)
Summer '04	11.5864**	(5.8476)		
Fall '04	5.6321	(5.4789)		
Summer '05			12.6164**	(5.9735)
Fall '05			-2.9902	(3.5281)
Summer '07			7.3281*	(4.3555)
R^2	0.5213		0.5081	
Obs	87		140	

Standard errors in parentheses. Asymptotic two-tailed significance levels: * 10 percent; ** 5 percent; *** 1 percent

Table 3. Regression of final exam performance on relevant homework, (1) before online grading (2) after online grading

Independent Variable	**(1) Before Online Grading**		**(2) After Online Grading**	
Homework #1 (Old)	3.1362*	(1.8240)		
Homework #2 (Old)	1.8947	(1.7970)		
Homework #3 (Old)	0.4457	(1.6675)		
Homework #4 (Old)	4.0903**	(1.9613)		
Homework #5 (Old)	3.1358*	(1.6517)		
Homework #6 (Old)	3.5962**	(1.6867)		
Homework #7 (Old)	4.6674**	(1.8224)		
Homework #8 (Old)	1.1219	(1.6662)		
Homework #1 (New)			-0.0305	(0.0812)
Homework #2 (New)			-0.0561	(0.0901)
Homework #3 (New)			-0.0026	(0.0723)
Homework #4 (New)			-0.1029	(0.0766)
Homework #5 (New)			0.1116	(0.1035)
Homework #6 (New)			0.2813***	(0.1043)
Homework #7 (New)			0.1099	(0.0768)
Homework #8 (New)			0.0839	(0.0707)
No. Submitted, 1st Half	-12.4215**	(5.4420)	3.2414	(5.6572)
No. Submitted, 2nd Half	-6.7012	(4.9813)	-4.8447	(4.8897)
Midterm Score	0.5373***	(0.0948)	0.4798***	(0.0700)
Summer '04	6.5092	(4.9461)		
Fall '04	1.3720	(4.4679)		
Summer '05			9.8884*	(5.2891)
Fall '05			-1.3470	(3.1116)
Summer '07			3.9309	(3.7844)
R^2	0.7215		0.6528	
Obs	86		138	

Standard errors in parentheses. Asymptotic two-tailed significance levels: * 10 percent; ** 5 percent; *** 1 percent

Table 4. Regression of final exam performance on all homework, midterm

	Correlation	No. Obs
Before Online Grading	0.7288	86
After Online Grading	0.6612	138

Table 5. Correlation of midterm exam performance with final exam performance

Semester	**No. Obs**	**Mean**	**Std. Dev.**	**95% Confidence Interval**
Summer	89	$\bar{x}_1$ =73.57	18.70	(68.47,78.68)
Spring or Fall	204	$\bar{x}_2$ =64.29	22.58	(61.46,67.17)
Spring	87	$\bar{x}_3$ =63.29	23.77	(58.52,68.05)
Fall	140	$\bar{x}_4$ =64.99	21.78	(61.36,68.62)

t test, equal variances assumed	**t Statistic**	**p-value**
$\mu_1 = \mu_2$ vs.$\mu_1 \neq \mu_2$	-2.8092	0.0053
$\mu_1 = \mu_2$ vs.$\mu_1 > \mu_2$	-2.8092	0.0027
$\mu_3 = \mu_4$ vs.$\mu_3 \neq \mu_4$	-0.5742	0.5663
$\mu_3 = \mu_4$ vs.$\mu_3 > \mu_4$	-0.5742	0.2832

Table 6. Comparison of Performance Across Semesters